Decision Rationale

Total Maximum Daily Loads for
the Aquatic Life Use Impairment on Blacks Run and Cooks Creek

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the TMDLs for the aquatic life use (benthic) impairment for Blacks Run and Cooks Creek. EPA's rationale is based on the determination that the TMDLs meet the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDLs are designed to implement applicable water quality standards.
2) The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.
3) The TMDLs consider the impacts of background pollutant contributions.
4) The TMDLs consider critical environmental conditions.
5) The TMDLs consider seasonal environmental variations.
6) The TMDLs include a margin of safety.
7) There is reasonable assurance that the TMDLs can be met.
8) The TMDLs have been subject to public participation.

II. Background

The Blacks Run and Cooks Creek watersheds are located in Rockingham County, Virginia. The Blacks Run watershed is 12,255 acres in size. The Cooks Creek watershed is 28,174 acres in size, including the Blacks Run subwatershed. The TMDLs address a 10.74 mile segment of Blacks Run and a 13.32 mile segment of Cooks Creek. The Blacks Run segment begins at its headwaters and terminates at its confluence with Cooks Creek. The Cooks Creek segment begins at its headwaters and terminates at its confluence with North River. Developed (82%) and agricultural (9%) lands make up 91% of the 12,255 acre Blacks Run watershed. Developed (43%) and agricultural (49%) lands make up 92% of the 28,174 acre Cooks Creek watershed. When the Blacks Run subwatershed is removed the Cooks Creek watershed the land use breakdown is 26% developed and 67% agricultural.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed 10.74 and 13.32 miles of Blacks Run and Cooks Creek on Virginia's 1998 Section 303(d) list as being unable to attain the general standard for aquatic life use and being impaired by elevated levels of fecal coliform. Both streams were unable to attain either standard. The failure to attain the general standard for aquatic life use was determined through biological assessments of the benthic macroinvertebrate community. This decision rationale will address the TMDLs for the impairment of the aquatic life use. Separate decision rationales and TMDLs have been developed for the fecal coliform impairments on Cooks Creeks and Blacks Run.

Virginia 305(b)/303(d) guidance states that support of the aquatic life beneficial use is determined by the assessment of conventional pollutants (dissolve oxygen, pH, and temperature); toxic pollutants in the water column, fish tissue, and sediments; and biological evaluation of benthic community data.[1] Therefore, a biological assessment of the benthic community can be used to determine a stream's compliance with the state's general standard for aquatic life use. Virginia uses EPA's Rapid Bioassessment Protocol (RBPII) to determine status of a stream's benthic macroinvertebrate community.[2] This approach evaluates the benthic macroinvertebrate community between a monitoring site and its reference station. Measurements of the benthic community, called metrics, are used to identify differences between monitored and reference stations.[3]

Reference stations are established on streams which are minimally impacted by humans and have a healthy benthic community. Streams which are classified as moderately or severely impaired after an RBPII evaluation are classified as impaired and are placed on the Section 303(d) list of impaired waters. During the 1998 assessment period, Blacks Run was scored as being moderately impaired while Cooks Creek was evaluated as severely impaired. Both streams were assessed as moderately impaired in 2000. Preliminary data for the 2002 assessment indicates that Blacks Run is now severely impaired while Cooks Creek is moderately impaired.

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[1]VADEQ. 1997. 1998 Water Quality Assessment Guidance for 305(b) Water Quality Report and 303(d) TMDL Priority List Report. Richmond, VA.

[2]Tetra Tech 2002. Total Maximum Daily Load (TMDL) Development for Blacks Run and Cooks Creek. Fairfax, Virginia.

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The RBPII assesses the health of the macroinvertebrate community of a stream. The analysis will inform the biologist if the stream's benthic community is impaired. However, it will not inform the biologist as to what is causing the degradation of the benthic community. Additional analysis is needed to determine the pollutants which are causing the impairment. TMDL development requires the identification of impairment causes and the establishment of numeric endpoints that will allow for the attainment of designated uses and water quality criteria.[4] A reference watershed approach was used to determine the stressors and the endpoints for these TMDLs. Numeric endpoints represent the water quality goals that are to be achieved through the implementation of the TMDL and will allow a stream to attain its designated uses. A reference watershed approach is based on selecting a non-impaired watershed that shares similar land use, ecoregion, and geomorphological characteristics with the impaired watershed.[5] The stream conditions and loadings in the reference stream are assumed to be the conditions needed for the impaired stream to attain standards.

The reference sites for Blacks Run and Cooks Creek were Opequon Creek and Hays Creek respectively. To determine whether these streams were similar to the monitored sites, the modelers evaluated the topography, soils, ecoregion, land uses, watershed size, and point source inventory of the potential reference sites. All reference site candidates had to score slightly impaired or better in the biomonitoring analysis. Hays Creek and Opequon Creek were determined to characterize the monitored sites fairly well. It should be noted that there were no potential reference sites (unimpaired streams) with an urban land use greater than 6%, Opequon Creek's watershed was 6% urban. The TMDL modelers evaluated all of the streams against the Virginia Ridge and Valley Multimetric Bioassessment Index (VRVMBI) which was developed specifically for these TMDLs. This method evaluated the streams against a subset of the RBPII metrics and other data. For additional information on reference site selection or the VRVMBI please see Section 2.0 of the TMDL document.

The next step in the TMDL development process was to determine the loadings and stressors in the monitored and reference watersheds. Low dissolved oxygen (DO), sedimentation, habitat modification, and toxic pollutants were evaluated as possible stressors to the monitored streams. Ambient water quality monitoring (AWQM) on all the streams documented temperature, DO, pH, turbidity, total suspended solids (TSS), ammonia, nitrates, total phosphorous, and fecal coliform. To get a better understanding of the daily DO concentrations, a diel DO analysis was conducted from October 03-06, 2000. DO concentrations and temperatures were evaluated over five-minute intervals for a 24-hour period each day. This data was extrapolated to document the daily DO cycles

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encountered around the AWQM.data. Toxicity testing was also conducted for water samples collected from the monitored sites. After this analysis, toxicity was not viewed as an issue on the monitored sites. In general the monitored sites had poorer water quality than the reference sites, please see Section 3.0 of the TMDL document for additional information. The analysis concluded that low dissolved oxygen due to excessive phosphorous loadings was a problem on Cooks Creek. It concluded that low dissolved oxygen may be a problem on Blacks Run, but no mechanism was definitively linked, flow alterations and lack of a riparian buffer were seen as possible causes. AWQM data indicating elevated levels of TSS and turbidity on both monitored sites identified sedimentation as a stressor to both streams. Habitat alteration (lack of riparian buffers) was also seen as a problem on both streams but not specifically included in the TMDL.

The next step in developing these TMDLs was to determine the loadings of phosphorous and sediment (the stressors) to the monitored and reference segments. The Generalized Watershed Loading Functions (GWLF) model was selected as the means to determine loadings to the streams. The GWLF model provides the ability to simulate runoff, sediment, and nutrient loadings from watersheds given variable source areas (e.g., agricultural, forested, and developed land).[6] GWLF is a continuous simulation model that uses daily time steps for weather data and water balance calculations.[7] Monthly calculations are made for sediment and nutrient loads, based on daily water balance totals that are summed to give monthly values.[8] To equate the reference watersheds with the monitored watersheds, the reference watersheds were reduced in size in the model, the land uses were proportionally reduced based on the percent land use distribution. Therefore, the land use breakdown in the reference watersheds remained constant.

Local rainfall and temperature data were needed to simulate the hydrology, this data was obtained from different sources for each watershed. The dDale eEnterprise station was used for Blacks Run and Cooks Creek. The Winchester 7SE, Winchester Winc, and the Dale Enterprise stations were used for Opequon Creek. While theThe Lexington and Kerrs Creek gages were used for Hays Creek. The hydrology calibration for Hays Creek was transferred from Kerrs Creek, since there was no gage on Hays Creek. Stream flow for Cooks Creek was determined through the gage at Blacks Run, this gage was in operation form February 20, 1999 through January 23, 2001. Opequon Creek was modeled to a gage located within the watershed. For additional information on the hydrology and water quality calibrations please turn to Section 5 of the TMDL document.

Table 1 - Summarizes the Specific Elements of the TMDLs.

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Segment	Parameter	TMDL (lbs/yr)	WLA (lbs/yr)	LA (lbs/yr)	MOS (lbs/yr)*
Blacks Run	Sediment	5,161,184	32,844	4,616,221	516,118
Cooks Creek	Sediment	11,197,507**	69,301**	10,041,299**	1,119,751**
Cooks Creek	Phosphorous	9,367	0	8,431	937

* Virginia includes an explicit MOS by reserving the 10% of total loading to the MOS.
**Value includes the WLA for Blacks Run.

The United States Fish and Wildlife Service has been provided with copy of this TMDL.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing aquatic life use (benthic) impairment TMDLs for Blacks Run and Cooks Creek. EPA is therefore approving these TMDLs. Our approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

The monitored sites were listed as impaired due to a degradation of the benthic macroinvertebrate community. As mentioned above, benthic assessments inform the biologist of an impairment, but they do not identify the stressor. Therefore a reference watershed approach was used to identify the stressors to these streams. Virginia has indicated that excessive levels of sediment and phosphorous have caused the degradation of the benthic community on Cooks Creek. Excessive levels of sediment were identified as the stressor to the Blacks Run impaired stream segment. The Commonwealth does not have numeric standards for either nutrients or sediment. Therefore, the loading obtained from the reference watersheds were used as the TMDL endpoints. It is believed that if these loadings are obtained, that the impairment to the benthic community will be relieved.

The GWLF model was used to determine the loading rates of sediment and phosphorous from the land as well as loadings to the stream from point and other direct deposit sources necessary to attain the general standard for aquatic life use. The TMDL modelers determined the sediment and phosphorous loading rates within each watershed. Data used in the model was obtained on a wide array of items, including farm practices in the area, the amount and concentration of farm animals, point sources in the watershed, wildlife in the watershed, land uses, weather, stream geometry, etc..

The GWLF model provides the ability to simulate runoff, sediment, and nutrient loadings from watersheds given variable source areas (e.g., agricultural, forested, and developed land).[9] GWLF is a

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continuous simulation model that uses daily time steps for weather data and water balance calculations.[10] To equate the reference watersheds with the monitored watersheds, the reference watersheds were reduced in size in the model, the land uses were proportionally reduced based on the percent land use distribution. Therefore, the land use breakdown in the reference watersheds remained constant. Local rainfall and temperature data were needed to simulate the hydrology, this data was obtained from different sources for each watershed. In the GWLF model, the nonpoint source load calculation is affected by terrain conditions, such as the amount of agricultural land, land slope, soil erodibility, farming practices used in the area, and by background concentrations of nutrients in soil and groundwater.[11] Parameters within the model account for these conditions and practices and were adjusted to insure that the hydrology and water quality calibrations matched the observed conditions as closely as possible.

EPA believes that using GWLF to model and allocate sediment and phosphorous loadings to the monitored segments will ensure that the designated uses and water quality standards will be attained and maintained on these streams.

2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest and agricultural land segments) and point sources. Activities that increase the levels of nutrients and sediment to the land surface or their availability to runoff are considered flux sources. The actual value for total loading can be found in Table 1 of this document. The total allowable load is calculated on an annual basis.

Waste Load Allocations

Virginia has stated that there are four point sources discharging within the Blacks Run and Cooks Creek watersheds. These facilities are Frazier Quarry and U.S. Training and Development Center in the Blacks Run watershed and the Dayton Water Treatment Plant (WTP) and Harrisonburg WTP in Cooks Creek. The permits for these facilities all include a TSS limit fo 30mg/L. None of the permits contain limits on nutrients. Nutrient limits were not required because the facilities were not seen as a source of this pollutant. The annual sediment loading from these facilities can be found in Table 2, and was determined by multiplying the concentration of sediment by the design flow.

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EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR 122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR 130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Table 2 - Waste Load Allocations for CooksMill Creek and Blacks Run

Stream	Facility	Permit Number	Allocated Load (lbs/yr)
Blacks Run	Frazier Quarry	VAG841011	32,768
Blacks Run	U.S. Training and Development Center	VAG401217	76
Cooks Creek	Dayton WTP	VA0090085	28,983
Cooks Creek	Harrisonburg WTP	VA0002674	7,474

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), LAs are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings, VADEQ used the GWLF model to represent the impaired watersheds. The GWLF model is a comprehensive modeling system for the simulation of watershed hydrology, point and nonpoint loadings, and receiving water quality. GWLF uses precipitation data for continuous and storm event simulation to determine total loading to the impaired segments from the various land uses within the watershed.

Table 3a - LA for Sediment for Blacks Run

Land Use	Existing Load (lbs/yr)	Allocated Load	Percent Reduction
Row Crops	2,606,771	1,616,198	38%

Pasture/Hay	1,568,986	988,461	37%
Barren	643,752	193,126	70%
Forest	12,637	12,637	0%
Urban (grouped pervious and impervious areas)	2,546,159	1,801,799	29%
Total	7,378,305	4,612,221	

Table 3b -LA for sediment for at Mouth of Cooks Creek

Land Use	Existing Load (lbs/yr)	Allocated Load (lbs/yr)	Percent Reduction
Row Crops	22,818,573	4,791,900	79%
Pasture/Hay	2,414,872	700,315	70%
Barren	786,106	78,611	90%
Forest	13,096	13,096	0%
Urban (grouped pervious and impervious)	1,241,324	606,620	51%
Total	30,273,972	6,190,542*	

*Does not included the allocated loads from Blacks Run.

Table 3c - LA for phosphorous at the Mouth of Cooks Creek

Land Use	Existing Load (lbs/yr)	Allocated Load (lbs/yr)	Percent Reduction
Row Crops	16,300	1,956	88%
Pasture/Hay	1,540	308	80%
Barren	500	50	90%
Forest	0	0	0%
Urban (grouped pervious and impervious)	2,240	681	70%
Groundwater	460	460	0%
Septic	440	264	40%
Total	21,480	3,709*	

*Does not included the allocated loads from Blacks Run.

3) The TMDL considers the impacts of background pollution.

The TMDLs considered background loadings for the pollutant of concern in the analysis.

4) The TMDL considers critical environmental conditions.

According to the EPA regulation 40 CFR 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the Blacks Run and Cooks Creek is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[12]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum. These critical conditions ensure that water quality standards will be met for other than worst case scenarios. By using the GWLF model, the modelers insured that all flow conditions were taken into account for loading calculations.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods. Consistent with our discussion regarding critical conditions, the GWLF model and TMDL analysis effectively considered seasonal environmental variations. The model also accounted for the seasonal variation in loading.

6) The TMDLs include a margin of safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling

[12]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL. Virginia includes an explicit MOS by allocating 10% of the total TMDL loading to the MOS.

7) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDL can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program. Additionally, Virginia's Unified Watershed Assessment, an element of the Clean Water Action Plan, could provide assistance in implementing this TMDL.

The TMDL in its current form is designed to meet the applicable water quality standards. The Commonwealth intends to implement this TMDL through BMPs. The implementation of these practices will occur in stages. This is will allow the Commonwealth to monitor the benefits of the BMPs and determine which practices have the greatest impacts on water quality. It will also provide a mechanism for developing public support and checking the accuracy of the model.

8) The TMDLs have been subject to public participation.

Two public meetings were held to discuss TMDL development on Blacks Run and Cooks Creek. Both of these meetings were public noticed in the *Virginia Register* and opened to a thirty-day comment period. The first meeting was held on April 12, 2001 in Dayton, VA. Eleven people attended this initial meeting on the TMDL. Fourteen people attended the second meeting which was held at VADEQ's Regional Office in Harrisonburg, VA on March 28, 2002.